Space Weather Technical Forecast

Issued on Tuesday, 23 January 2024 at 13:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: CME arrival forecast late on 25 January or early on 26 January, with G1/G2 storming likely. Moderate solar activity likely to continue. Chance of radiation storms throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with multiple M-class flares observed from AR3559 (Fki/βγδ) in the northeast and AR3561 (Eai/βγδ) in the southwest. The peak flare of the last 24 hours, a M5.1 flare at 23/0331UTC appears to have had a contribution from both these spots. The remaining five regions appear to be mature or stable.

The most significant CME in the forecast so far was from the south centre disc around 22/1000UTC. This has been modelled with a possible arrival late on 25 January or early 26 January. There also appear to have been one CME associated with M-class flares from AR3559, with a partial halo shock, and three CME's from AR3561, which will be all be analysed once sufficient imagery becomes available. All other CME's visible in coronagraph imagery appear to have been far-sided or not Earth-directed.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by ACE and DSCOVR, initially varied between slightly elevated and ambient, but increased to around 500km/s from 22/1600UTC due to the arrival of a CME which left the Sun on 20 January. This has since declined to just over 400km/s. Density started below average but increased to just above average following the CME arrival, reaching a peak of around 12ppcc at 22/1650UTC, declining back to average in the last few hours. Total magnetic field strength increased from weak to moderate levels, peaking at 13nT at 22/1713UTC, but has declined to weak since the early hours of this morning. Bz has varied moderately throughout, with a greater oscillation after the CME arrival, reaching a negative peak of -12nT at 22/1937UTC. Phi angle was mainly positive (away from the Sun). Resultant geomagnetic activity has been largely Quiet but increased to Unsettled from 22/1800UTC until 22/2400UTC.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was above normal background levels at first, although below the S1 (Minor Storm) threshold, reaching a peak of 7pfu at 22/1635UTC before declining.

GOES16 high energy (greater than 2MeV) electron flux was at background levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold on a steady trend. At 23/0001UTC the 24-hour integrated fluence observation was 1.88e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: M-class flares are likely throughout from AR3561 and the AR3559, with a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: A CME is forecast to arrive at Earth late on 25 January or early on 26 January, giving a chance of G1/Minor or G2/Moderate Storm intervals late on 25

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

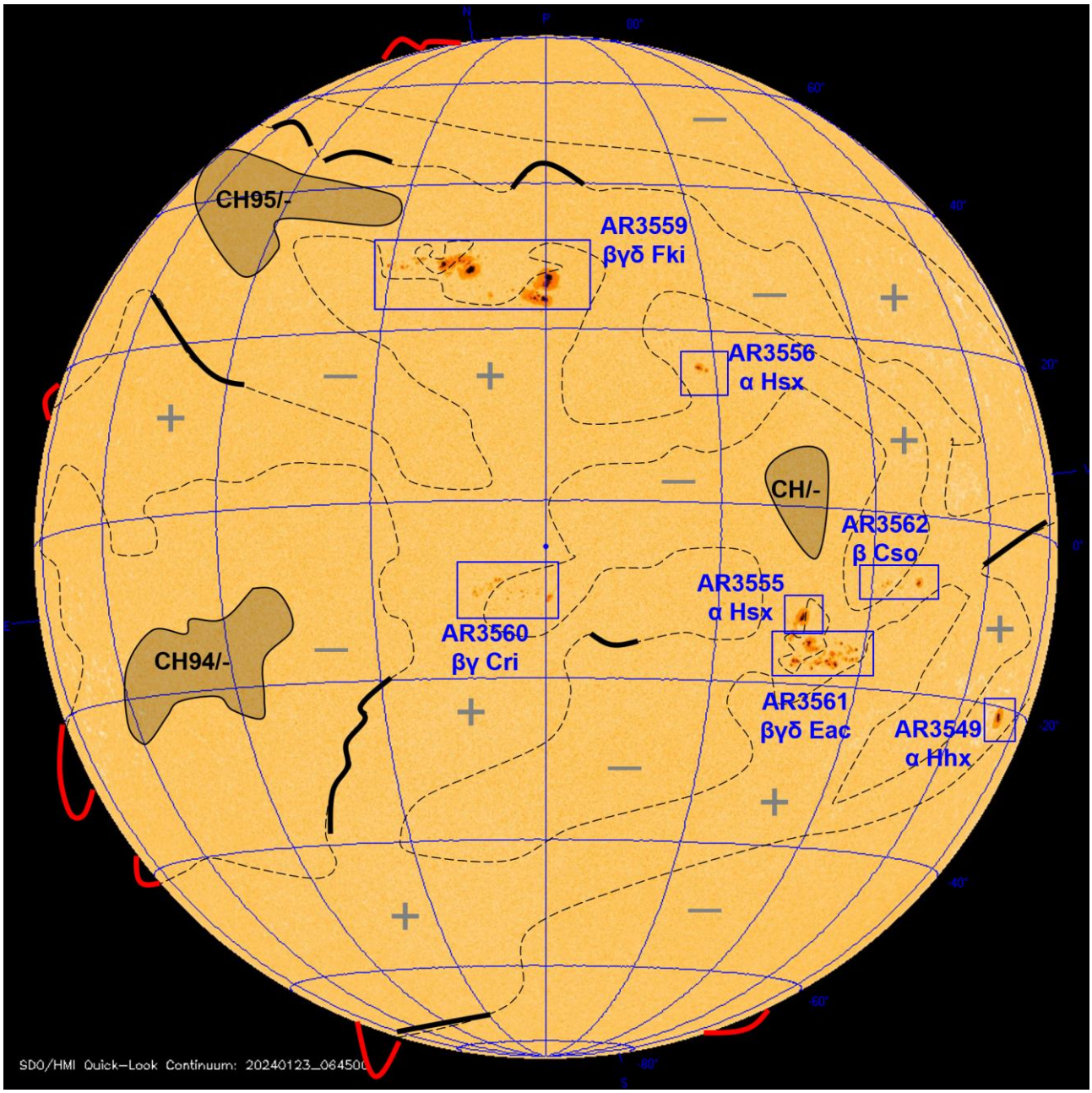
© Crown Copyright 2024. All Rights Reserved.

January, becoming more likely into 26 January.

Energetic Particles / Solar Radiation: There is a daily chance of radiation storms throughout, due to residual risk from the M2 flare at 23/0811UTC, the high magnetic complexity of AR3561 in the western hemisphere and the rotation of AR3559 into the western hemisphere.

The high energy electron (greater than 2MeV) flux is uncertain due to the effects of multiple CME arrivals on the forecast, but will most likely remain at background levels during the next four days. Electron fluence values reflect have a low probability of reaching the Active threshold.

Figure 1. Solar Analysis Valid 23/0645.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Met Office Space Weather Technical Forecast

Geomagnetic Storms:

A large eruption from the south centre disc around 22/1000UTC is forecast to arrive at Earth late on 25 January or early on 26 January, with a higher confidence, based on multiple fits of passing Earth orbit, but lower confidence in how much of the CME may affect the Earth. This gives a chance of G1/Minor or G2/Moderate Storm intervals late on 25 January, becoming more likely into 26 January.

A weak coronal hole has been identified in centre disc, but this is unlikely to enhance the solar wind significantly. Any HSS from CH95/- is not expected to affect Earth until after Day 4 (26 January).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	40	60
Strong	G3	No	1	1	5	10
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

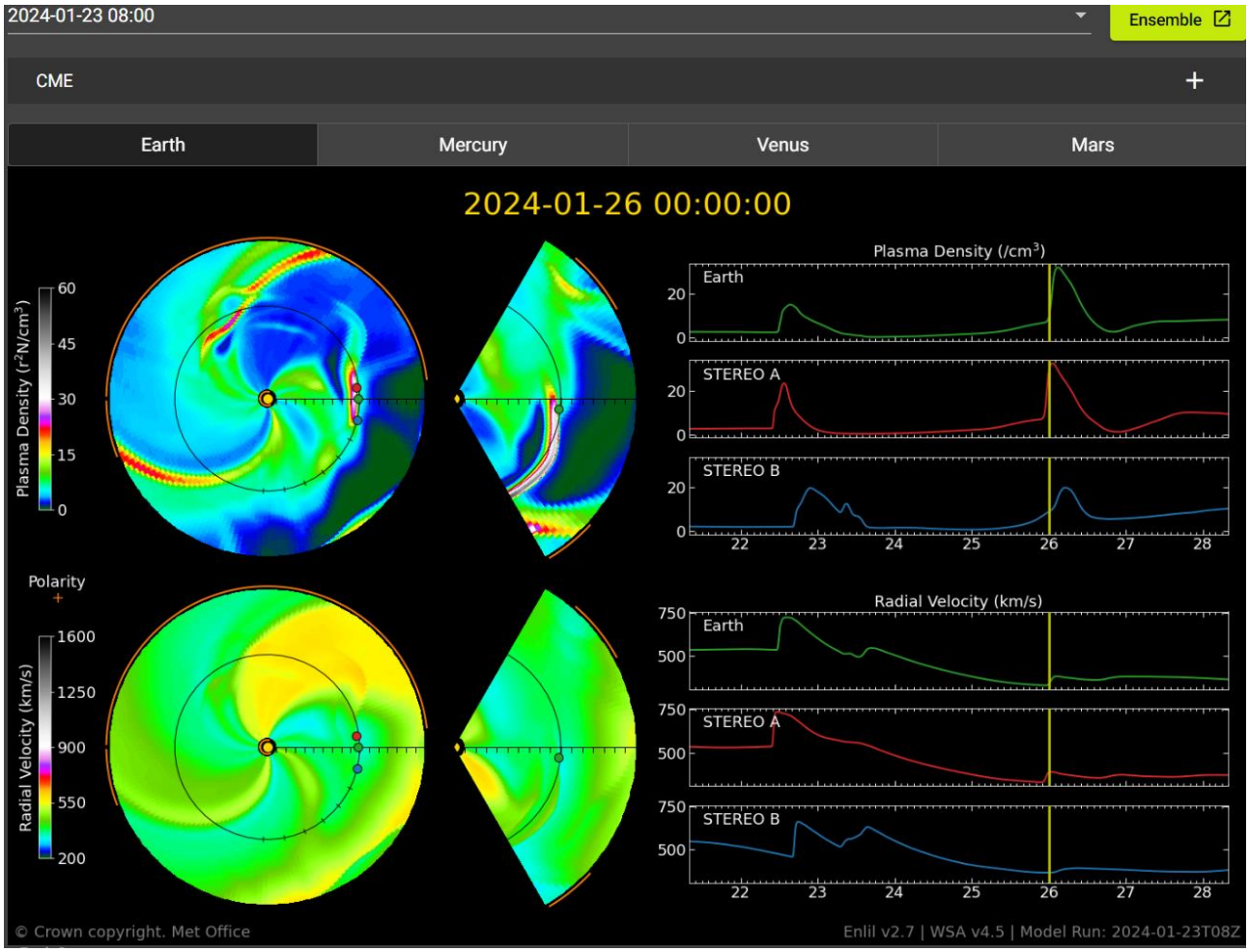
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
22/1559	Partial	Filament eruption	South-centre disc	620km/s	26/0001UTC	Uncertainty in how direct the impact will be

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 2: MOSWOC ENLIL 23/0800UTC run. Thought to be giving good guidance on arrival of CME.



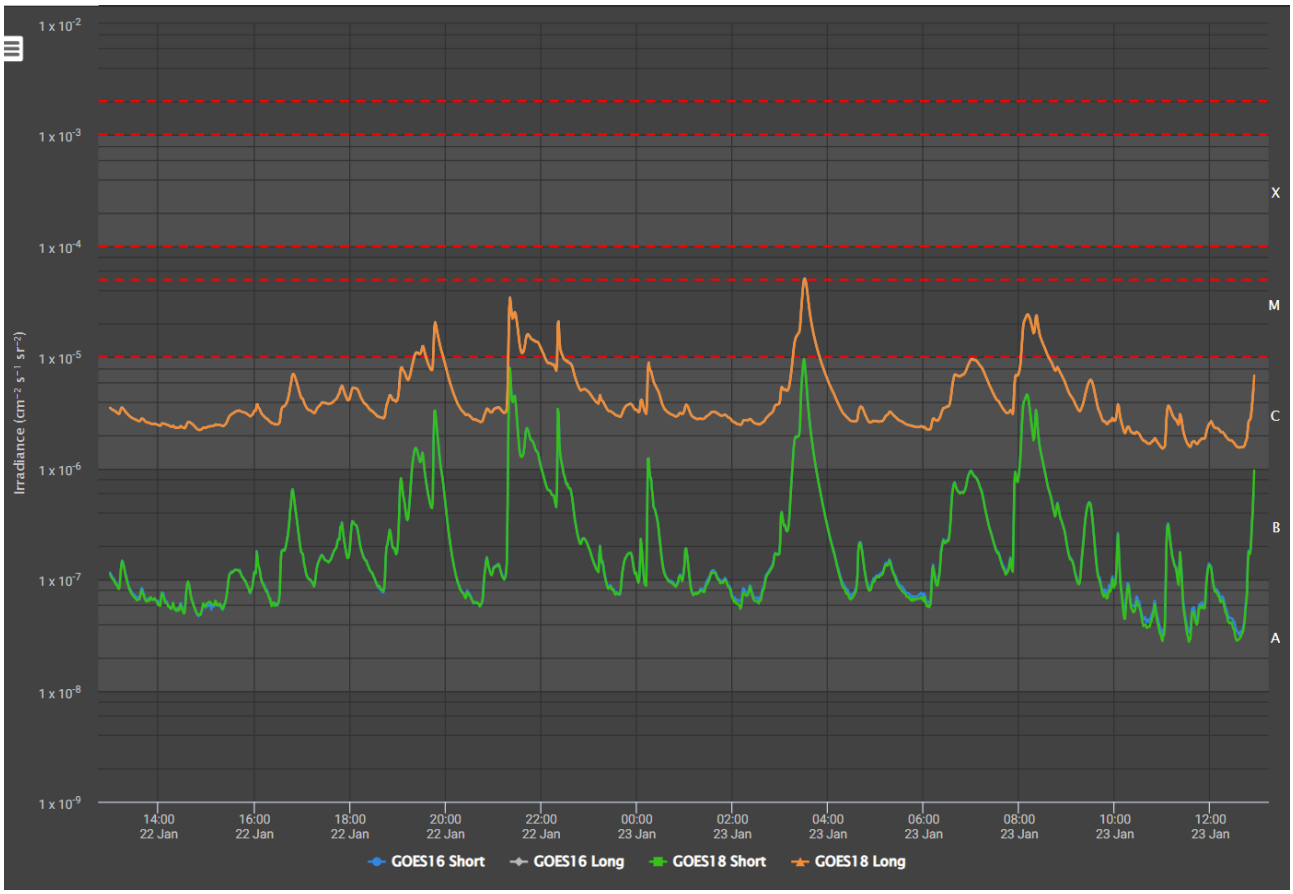
© Crown Copyright 2024. All Rights Reserved.

Radio Blackouts - X-Ray Flares:

The two most active regions on the disc are AR3561 and AR3559, both producing M-class flares over the last 24 hours. AR3561 in the southwest has shown rapid development in both size and complexity over the last 24 hours, with a contorted delta spot in the centre of the group. AR3559 is a large and extremely complex sunspot region in the northeast quadrant. Both these regions remain on the disc throughout the next four days, so further M-class flares are likely, with a chance of X-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	15	15	15	15

Figure 3: X-Ray flares, showing multiple M-class flares.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

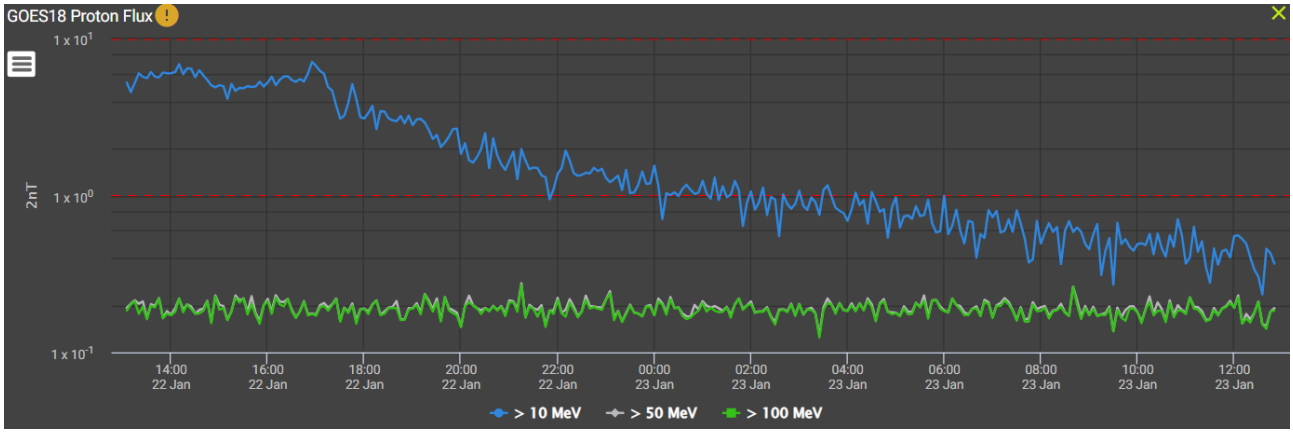
Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is currently slightly elevated, but on a falling trend.

There is a residual risk of protons from the M2 flare on 23/0811UTC, giving a chance of minor proton storms later on 23 January. There is a slightly lower daily chance of radiation storms throughout, due to the high magnetic complexity of AR3561 in the western hemisphere and the imminent rotation of AR3559 into the western hemisphere during the next 24 hours.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	30	25	25	25
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES18 Proton Flux



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

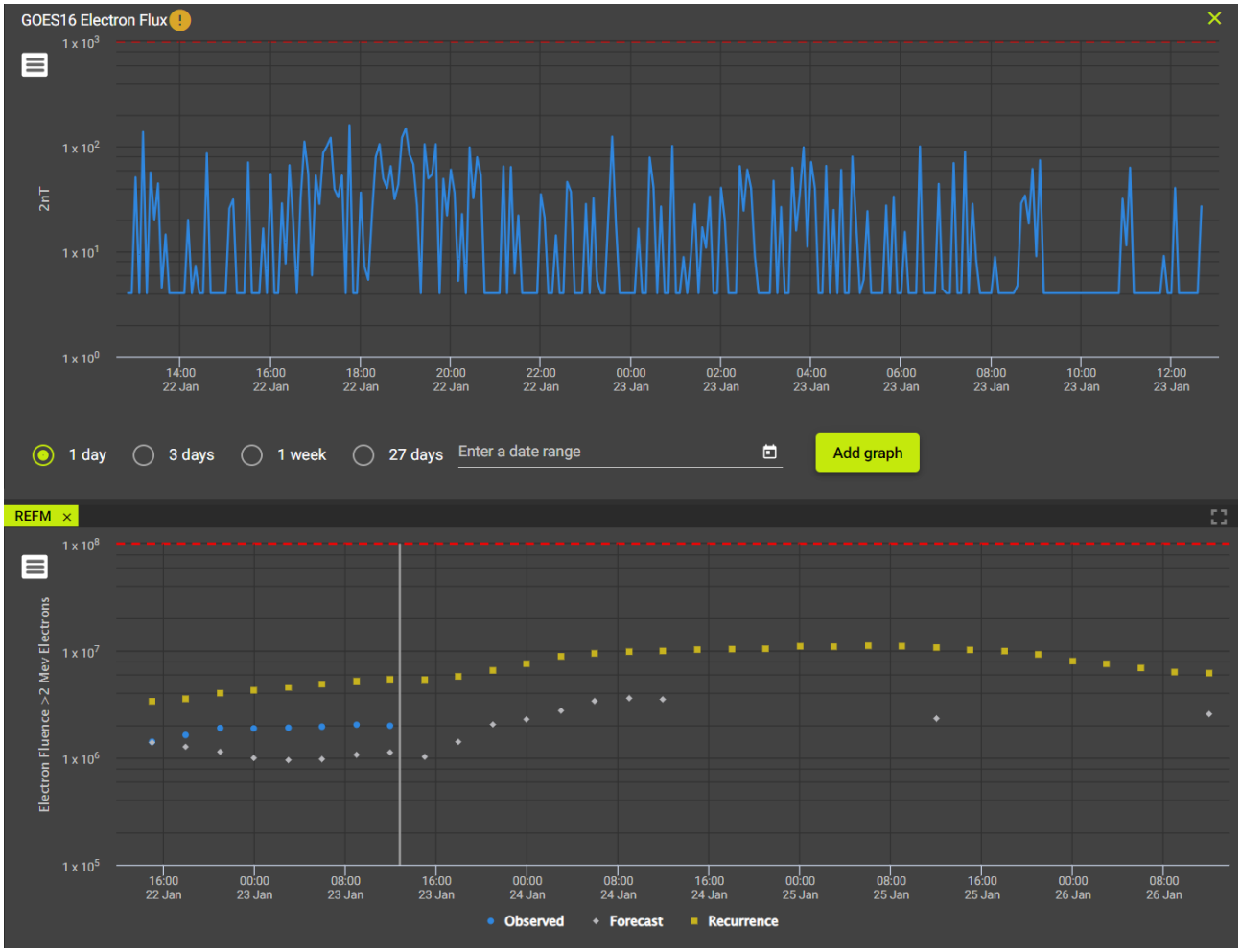
High Energy Electrons Event (≥ 2MeV):

The high energy electron (greater than 2MeV) flux is uncertain due to the effects of multiple CME arrivals on the forecast, but will most likely remain at background levels during the next four days.

Electron fluence values reflect this uncertainty, with only a low probability of reaching the Active threshold, assuming a sharp and sustained increase in the electron flux.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	5	5	5
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: GOES16 Electron Flux (top) and MOSWOC REFM (bottom). Note that REFM will not model effects of CME's in the forecast.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.